CLAIMS

What is claimed is:

1. An apparatus for producing a modulated optical signal in a waveguide, comprising:

an antenna for communicating with the waveguide and with an externally-applied optical field and having an output port; and

an electrically-variable-impedance device connected at the output port of the antenna, capable of responding at a frequency of an externally-applied optical field and having its impedance at the optical frequency changed by an applied electrical signal.

2. The apparatus as in Claim 1, wherein the electrically-variable-impedance device comprises a tunnel junction.

3. The apparatus as in Claim 2, wherein the tunnel junction comprises a metal-insulator-metal (MIM) structure.

4. The apparatus as in Claim 3, wherein the MIM tunnel junction comprises closely juxtaposed metal lines with a layer of metal oxide therebetween.

5. The apparatus as in Claim 4, wherein a metal line comprises nickel and the oxide comprises nickel oxide.

6. The apparatus as in Claim 5, wherein an area of the junction is less than 100 nm square.

7. The apparatus as in Claim 3, wherein a capacitance of the MIM junction is less than 100 attofarads.

8. The apparatus as in Claim 2, wherein the electrically-variable impedance device comprises a Josephson junction.

9. The apparatus as in Claim 1, wherein the electrically-variable impedance device comprises a Schottky barrier.

10. The apparatus as in Claim 2, wherein the electrically-variable impedance device comprises a metal-insulator-superconductor barrier.

11. The apparatus as in Claim 2, wherein the tunnel junction comprises a resonant tunnel diode.

12. An apparatus for detecting an optical signal in a waveguide, comprising:

an antenna structure for communicating with the waveguide and having an output port; and

an electrically-connected detector connected at the antenna's output port, capable of responding at a frequency of the optical signal in the waveguide and for producing a detected electrical signal at baseband.

13. The apparatus as in Claim 12, wherein the electrically-connected detector comprises a tunnel junction.

14. The apparatus as in Claim 13, wherein the tunnel junction comprises a metal-insulator-metal (MIM) structure.

15. The apparatus as in Claim 14, wherein the MIM tunnel junction comprises closely juxtaposed metal lines with a layer of metal oxide between them.

16. The apparatus as in Claim 15, wherein a metal line comprises nickel and the oxide comprises nickel oxide.

17. The apparatus as in Claim 16, wherein an area of the junction is less than 100 nm square.

18. The apparatus as in Claim 14, wherein a capacitance of the MIM junction is less than 100 attofarads.

19. The apparatus as in Claim 12, wherein the electrically-connected detector comprises a Josephson junction.

20. The apparatus as in Claim 12, wherein the electrically-connected detector comprises a Schottky barrier.

21. The apparatus as in Claim 12, wherein the electrically-connected detector comprises a metal-insulator-superconductor barrier.

22. The apparatus as in Claim 12, wherein the electrically-connected detector comprises a resonant tunnel diode.

23. The apparatus as in Claim 12, wherein the electrically-connected detector comprises a semiconductor tunnel junction.

24. An apparatus for optical information transmission, comprising:

a waveguide;

a transmitting antenna structure for communicating with the waveguide and having an output port;

a receiving antenna structure for communicating with the waveguide and having an output port;

an electrically-variable-impedance device connected at the transmitting antenna's output port, capable of responding at a frequency of an externally-applied optical field and having its impedance at an optical frequency changed by an applied electrical signal; and

an electrically-connected detector connected at the receiving antenna's output port, capable of responding at the frequency of an optical signal in the waveguide and producing a detected electrical signal at baseband.

25. The apparatus as in Claim 24, further comprising:

a source of optical radiation illuminating the transmitting antenna structure, at whose wavelength the waveguide structure transmits optical radiation from the transmitting antenna structure to the receiving antenna structure.

26. The apparatus as in Claim 25, wherein the optical radiation is incident on the transmitting antenna by guided propagation in the waveguide structure.

27. The apparatus as in Claim 25, wherein the optical radiation is incident on the transmitting antenna by unguided propagation.

28. A method for launching a modulated optical signal into a waveguide, comprising:

providing a waveguide with an antenna structure for communicating with the waveguide and with an external optical field, and having an electrical output port;

connecting an electrically-variable impedance device to the output port of the antenna structure;

illuminating the antenna structure with an external optical beam at a wavelength at which the waveguide can transmit, so that a portion of the optical field is scattered into a waveguide mode; and

applying an electrical signal to the electrically-variable-impedance device so as to modulate the portion of the optical field scattered into the waveguide mode by changing the terminating impedance seen by the antenna structure.

29. A method for launching a modulated optical signal into a waveguide, comprising:

providing a waveguide with an antenna structure for communicating with the waveguide and with an external optical field, and having an electrical output port;

connecting an electrically-variable impedance device to the output port of the antenna structure;

illuminating the antenna structure with a guided optical beam in a waveguide mode at a wavelength at which the waveguide can transmit, so that a portion of the optical field is lost from the waveguide mode; and

applying an electrical signal to the electrically-variable-impedance device so as to modulate the portion of the optical field lost from the waveguide mode by changing the terminating impedance seen by the antenna structure.

30. A method for detecting a modulated optical signal in a waveguide, comprising:

providing a waveguide with an antenna structure for communicating with the waveguide and having an electrical output port; and

connecting an electrical detector for responding at the optical frequency to the output port of the antenna structure.

31. The apparatus according to claim 1, wherein a portion of the externally-applied optical field is scattered within said waveguide.

32. The apparatus according to claim 1, further comprising:

a second waveguide adjacent said waveguide, wherein the externally-applied optical field is scattered from said waveguide to said second waveguide.

33. The apparatus according to claim 1, wherein illumination by said optical field is performed along said waveguide.

34. The apparatus according to claim 1, wherein illumination by said optical field is performed above a top surface of said waveguide.

35. A waveguide junction, comprising:

the apparatus of claim 1 for switching from a first output waveguide to a second waveguide.

36. The apparatus according to claim 12, wherein said detector performs coherent detection.

37. The apparatus according to claim 12, wherein said detector performs direct detection.

38. A communication system, comprising:

a logic gate; and

a plurality of ones of the apparatus according to claim 1, each of said plurality of apparatus being connected to said logic gate to form a one-to-many connection.

39. An apparatus for launching a modulated optical signal into a fiber, comprising:

a fiber;

an antenna for communicating with the fiber and with an externally- applied optical field and having an output port; and

an electrically-variable-impedance device connected at the output port of the antenna, capable of responding at a frequency of an externally-applied optical field and having its impedance at the optical frequency changed by an applied electrical signal.

40. A fiber local area network (LAN), comprising:

the apparatus of claim 39.

41. An optical backplane, comprising:

first and second circuit boards; and

the apparatus of claim 1 formed between said first and second circuit boards.

42. A circuit board incorporating the apparatus of claim 1.

43. A chip module incorporating the apparatus of claim 1.

44. An optical communication system, comprising:

the apparatus of claim 1; and

a plurality of interconnects, wherein said externally-applied optical field is used for each of said plurality of interconnects, so as to form a one-to-many connection.

45. An optical communication system, comprising:

the apparatus of claim 1; and

a plurality of interconnects, wherein said externally-applied optical field is used for each of said plurality of interconnects, so as to form a many-to-many connection.

46. An apparatus for launching optical information in a waveguide, comprising:

a waveguide;

an antenna structure for communicating with the waveguide and having an output port;

an electrically-variable-impedance device connected at the antenna's output port, capable of responding at more than one frequency of an externally-applied optical field and causing the antenna to radiate a mixing product between the optical frequencies.

47. An apparatus for detecting optical information in a waveguide, comprising:

a waveguide;

an antenna structure for communicating with the waveguide and having an output port;

an electrically-coupled detector at the antenna's output port, capable of responding at more than one frequency of an optical field in the waveguide and producing a detected electrical signal at a frequency corresponding to a mixing product of the optical frequencies.